Critical Analysis of Network Protocols Used in Modern Computer Networks

Maham Rabbani*, M. Aqeel Iqbal and Qurat-ul-Ain Malik

Department of Software Engineering

Faculty of Engineering and IT, FUIEMS, Rawalpindi, Pakistan

maham7@live.com, maqeeliqbal@hotmail.com, aneylalazar@yahoo.com

Abstract - The need for the protocols is increasing day by day as the protocols are becoming an important part of the network based computing. Protocols are basically some set of rules defined for communication through which the network devices communicate with each other and exchange information with each other. The protocols have been divided into different categories depending upon their functionality and usage. There are wide varieties of protocols that currently exist which have been defined by some network based standard throughout the world. This research paper presents a critical review of existing protocols with their functionalities usage and applications. This research paper points out the limitations and variations in existing protocols and guides about the feasible methods to administer the issues.

Keywords – Computer Networks; Wireless Networks; Network Protocols; Network Layers; Network Topologies

I. INTRODUCTION

Networking is a very wide and complicated field that we cannot exactly define its origin. But we can say that concept of the networking was first time introduced in 1960s. In 1960s the networking was identical to the mainframe computing and the telephonic services and also at that time there was no division between the local area and the wide area networks. Later on the work on the first network of the history of networking the ARPANET began in the 1960s, and later on in the year 1969 a four-node networking network using primitive packet switching was created.

In the 1960 the mainframe technology was used, later 1970 was the era of Ethernet technology. Ethernet was published in 1980. Similarly the Xerox networking system was introduced known as X-wire was named after the Xerox's researcher and it was able to work at 2.94 Mbps speed.

In the era of 1980, there was a wide increase in the use of client/server environment while the mainframe computing environments had got a decline. Similarly in 1985 a large number of UNIX machines and LANS were connected to the APRANET. Later on a lot many more developments were made in the field of the networking and still a lot of developments are made in the networking technology [1].

A network basically consists of system of computers, terminals and the databases connected together by means of communication lines. Networking is a process through which two or more devices communicate with each other to share the data and also to share resources with each other. As shown in the following figure:
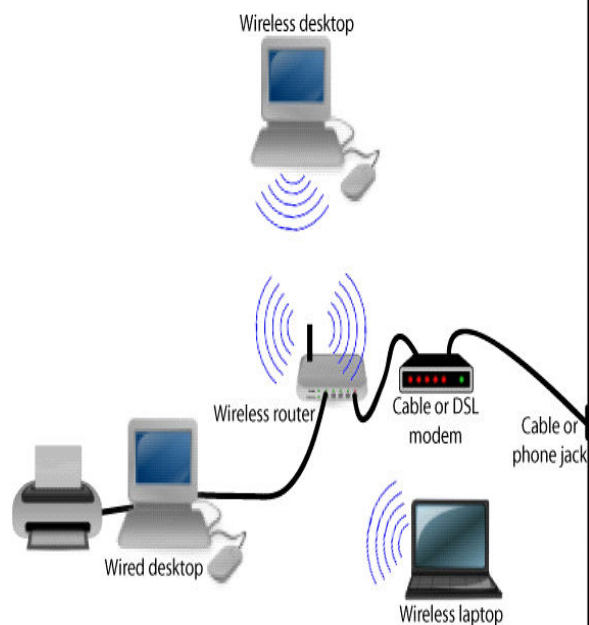

Figure-1: Shows Networking Model

Protocols are basically some set of rules defined for communication through which the network devices communicate with each other and exchange information with each other. The protocols of humans are for speaking, listening, appearance and for the communication purpose. This set of communication is called protocols of human communications or conversation. A network protocol is a set of rules must be followed by the two of the communication devices in order to talk with each other.

A network protocol is formally defined as an agreed upon set-up for the transmission between the two devices. A network protocol determines the following:
- Data formats for the data exchange of the data.
- Detection for the transmission errors because no network is error-free.

- Acknowledgement for the correct transfers of the packets of data by receiver are used to tell the sender that retransmission of data is not needed.
- Loss of the data. Sometimes the packets of the data are lost on the network or may suffer with delay.

Designing of the protocols is done using different software tools. The communication system always operates parallel. Tools of programming and the techniques used for dealing with parallel processes are called as "concurrency of programming". This type of programming is an important concept in the operating systems theories. Mathematical approach for the studying of communication and concurrency referred as the use of finite machines. This type is a bit challenge for usage so therefore all of the things must be kept simple. Basis for the protocol design is the internet protocol. For the cooperation purpose the protocols need to communicate with one and other, for this a framework is required.

Serial communications in-order to take place properly, many functions has to be made possible for that. First requirement is that, the receiver and the sender computers must be made in such away so that they can control their actions also can enable the flow control of the data [2], [3]. The process of the addressing helps to send the data packets to the desired location. Lastly the management of connection is a set of functions that are linked with the maintenance of the connection. The receiver must know everything related to the data packet that is being transmitted.

II. TYPES OF PROTOCOLS

There are different types of the protocols that are commonly used and some are yet to be developed for the future usage. Some of the protocols that are commonly used are:

A. TCP/IP PROTOCOL

This protocol is collection of different set of protocol suites .TCP/IP was used to give birth to global internet. TCP/IP name has been made out of two core protocols TCP and IP [4]. Other core protocols in this suite are UDP and ICMP all these protocols work in a collective manner to attain similar goals but in a different way it is not only used on the internet but they are also extensively used to construct private networks with in a organization like "intranets". TCP and IP were made by the United States military to let two or more computing communicate to each other at long distances [4], [5]. IP has the responsibility to transfer packets of data between two computing devices whereas TCP has the responsibility of authentic delivery from any server to its clients [5].TCP/IP is constructed in a way that that it provides a base for the internet as it is been inherent in every existing modern systems as well as UNIX, MAC and WINDOWS.TCP/IP is a two layered program. The higher or the upper layer is the TCP which assembles the messages or the files into small packets of the data that are sent on the internet and are received by the upper layer which than retransform the data packets into original message [6]. The second or the lower layer is the IP layer, which handles address part of each of the data packets so that it is sent to its right place. A gateway between the networks checks all the addresses to check where the message is to be sent. The

TCP/IP communication is basically point to point. TCP/IP uses the client server environment for the communication purpose in the network [5].
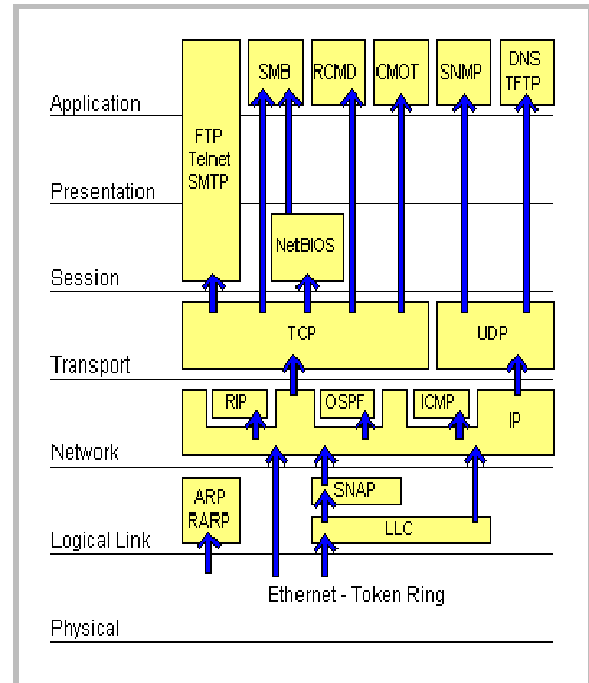

Figure.2 Network Layers and Used Protocols

FUNCTIONS OF TCP/IP:

A. Multiplexing and Addressing:

One of the main functions of the TCP/IP is to perform the multiplexing/addressing. The data is received from many processes so that it can be sent through the network protocol layer. Also all of the high level application processes are managed through the TCP ports.

B. Connection Establishment, Its Supervision and Its Termination:

Table-1: Shows Comparison of TCP/IP Protocol

FUNCTION	TCP/IP	UDP
Setup Of connection	TCP/IP takes little time in-order to ensure consistency.	In UDP the connection is not compulsory.
Assurance of message deliverance	TCP/IP sends acknowledgement when the packet of data is received.	UDP cannot tell whether data is correct sent or not.

Packet sequence	The data packets are transmitted in proper order.	Data packets are not send properly in order.

TCP/IP provides a set of rules that all of the devices must follow in-order to begin and also settle a TCP/IP connection through which the data can be sent. TCP/IP includes some reasons for management of connection and also controlling of problems that may occur. When a device gets TCP /IP connection, some a particular procedure is used in-order to stop the connection.

C. Data Packages and their Handling:

The TCP/IP sets a procedure through which all of the applications can send the data to the TCP/IP. Data is coded into messages that are to be sent to the receiver which is the TCP/IP software. The Receiving software un-codes the data and sends it to the required application which is on the receiving machine.

D. Transfer of Data:

TCP/IP execution on a transmitting device is answerable for the transfer of data packets to the TCP/IP process which is on another device. It follows the procedure of layering which is done by using the TCP/IP software on the receiving machine which than sends data packets to the network-layer protocol that is the Internet Protocol.

ADVANTAGES OF TCP/IP PROTOCOL:

- TCP/IP is used to set up connections between different types of servers and computers.
- TCP/IP is an open and also industry standard protocol.
- It is operated separately without the interference of operating system.
- It also supports the routing protocols.
- Sets up internal networking between the different organizations.

DISADVANTAGES OF TCP/IP:

- TCP/IP protocol is much slower than IPX.
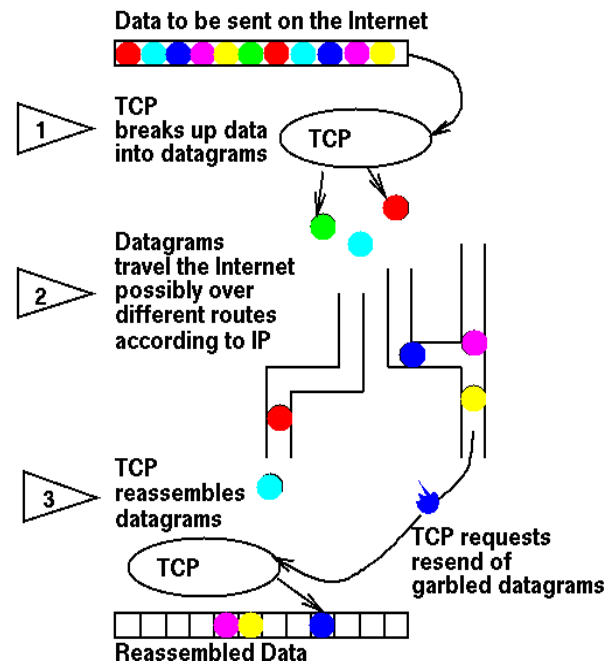- It is very much complex in-order to administer and establish.

Figure.3 Shows Data Transmission in TCP Protocol

B. USER DATAGRAM PROTOCOL (UDP):

UDP is a protocol which does not require any type of connections. UDP helps to do the host to host communication.UDP (User Datagram Protocol) in the OSI model belongs to the transport layer .The services UDP provides or unpredictable, no assure about delivery and defense against recurrence.UDP offers a negligible ,un trusted but on the other hand offers a more trusted n best messaging transporting service to the applications this protocol is for communication purpose and it provides restricted number of services when messages or the data is exchanged or send between two or more computers within the network. UDP can be deployed where TCP is already deployed but as TCP assures about the reliability, sequence of data transferred it does not. Data -grams can go missing without any notifications. UDP collectively with IP is also called as UDP/IP. The application program which uses UDP must make clear that the message has reached in the correct order. Network applications which have small data packets for exchange and also all those which want to save the time required for the processing of data do prefer to use the UDP protocol instead of TCP.
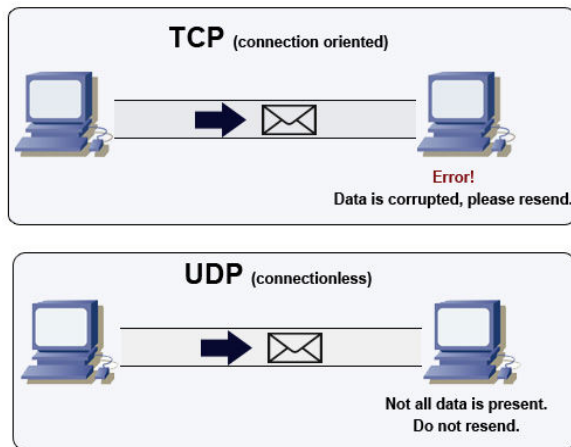
Figure.4 Flow of Data in TCP and UDP

FUNCTIONS OF UDP:

A.   Wireless Services:

In UDP no connection is required for transmission of data packets; it provides wireless services for the data packets transfer throughout the whole network. This means every datagram sent by the UDP is an autonomous datagram. There is no connection between any datagram being sent to the receiver even though they are sent by the same source program.

UDP does not establish any connection as already known and also it does not establish ant termination connection as TCP does so in reaction any datagram can travel on any path. Due to its wireless service it sends short messages which are sliced down to different related user datagram by UDP.

B.   Flow control:

UDP doesn't provide any flow control of data packets in the network the receiver may overflow with incoming messages.. Data is randomly sent without any sequence and there is no option or service to re-transmit the data if it is not sent due to any error or any other reason. Whenever the user notices an error through the checksum, user datagram is mutely removed or deleted.

C.   Operation of Queuing:

When a process is started an incoming and outgoing queue is associated with each process by the client and is differentiated by port ephemeral number of each process. Whenever a process is terminated the queue associated with that process is also terminated. UDP always checks whether an incoming queue for the port number of user is created or that otherwise the UDP discards that datagram of the user.

ADVANTAGES OF UDP:

- Over head in UDP is less.
- Transmission of the data is fast.
- UDP is very much useful in the applications that don't require any data fragment.

DISADVANTAGES OF UDP:

- There is no guarantee that data is properly delivered or not also data may get lost and may not be resent.
- In UDP there is   no proper ordering of data packets.

C. HYPER TEXT TRANSFER PROTOCOL (HTTP)

HTTP is the protocol which is mainly used by the web servers. HTTP tells how to format and transmit the messages and what procedures to be used by the internet browsers and all the Web servers for various actions to be performed. HTTP is also known as stateless protocol because all of the commands and actions are performed independently. It gives the users a set of rules for exchange of the data. HTTP is same like FTP. But on the other hand it is rather more similar than the FTP for it only uses one TCP connection. The reason of similarity between HTTP and SMTP is due to the data that is being transmitted between users and sever. As SMTP messages are not human readable so are the HTTP messages. These messages are only interpretable by HTTP server and its client i.e. (browsers). The commands sent by the user to the server are in the embedded format of a request message. The contents of the requested file are in embedded format of a response message.
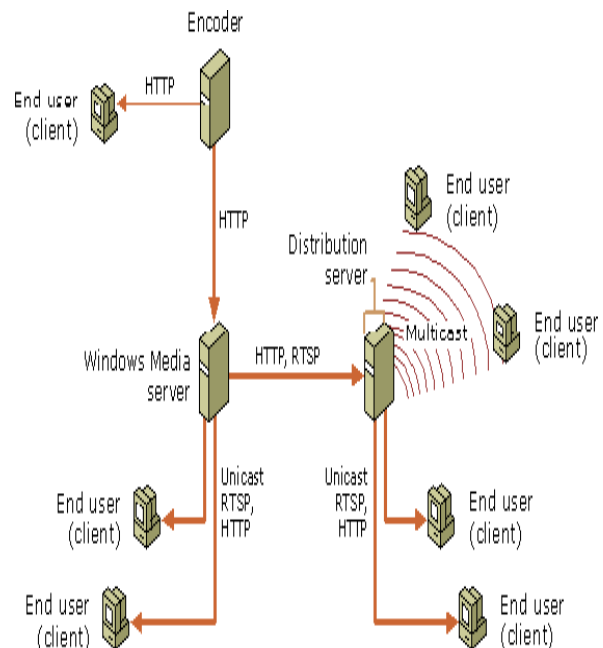

Figure.5 Usage of HTTP protocol

HTTP FUNCTIONS:

Functions of HTTP are the combination of FTP and SMTP.

Table-2: Functions of HTTP

| FUNCTIONS	DESCRIPTION
Header list()	It will return a list of header responses that are sent or waiting for their turn to be sent.
Header()	It sends some raw HTTP header to the client of the server.
Header sent()	It checks if the HTTP headers have been successfully sent or not.
Setrawcookie()	It sends an HTTP cookie without URL encoding.
Set cookie()	HTTP sends HTTP cookie to the client.
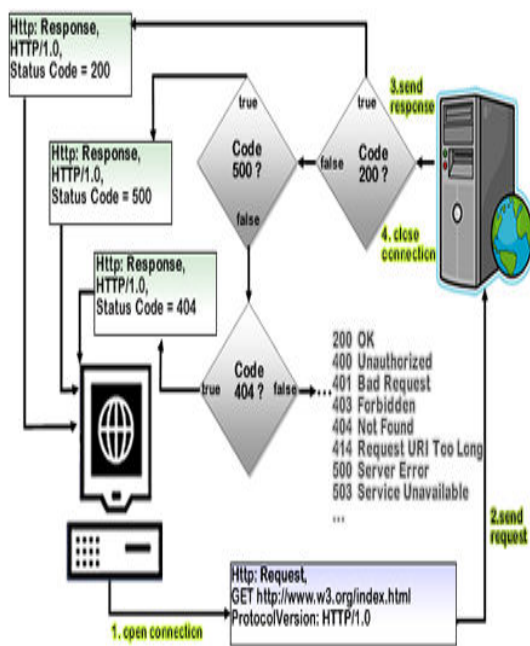
Figure.6 HTTP Based Handshaking

Figure Courtesy:
http://regina-meyer.com/images/tut_php/img_HTTP-status-code.png

ADVANTAGES OF HTTP:
- HTTP is connectionless protocol.
- HTTP not depends on media for data transmission.
- In HTTP both the user and the server are well aware of each other.

DISADVANTAGES OF HTTP:
- HTTP is a stainless protocol.

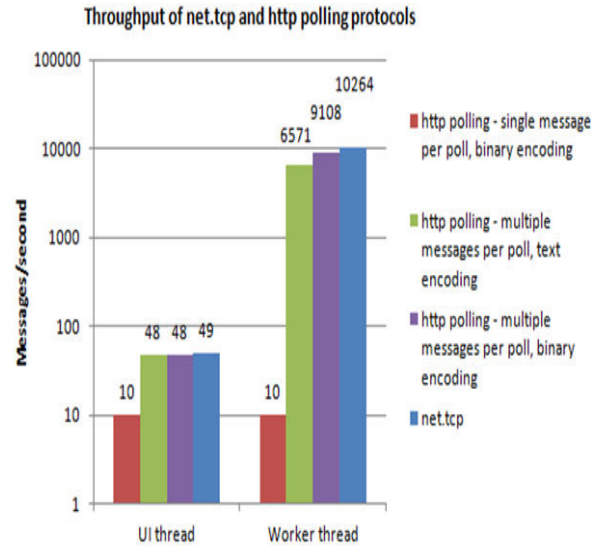- In HTTP protocol there is no security mechanisms.

Figure.7 HTTP and TCP Protocol

D. FILE TRANSFER PROTOCOL (FTP):

FTP stands for File Transfer Protocol; it is particularly used for the exchange of files or information on the internet. It uses the TCP/IP protocol to enable the data transfer on the internet. It is particularly used for uploading a file on the server using the internet or for downloading the files from the main computer by using the internet. Even the file transferring from one system to other system appears too easy but difficulties related to the functionality of FTP do come. For example the two system or the host who are exchanging or transferring files also these two systems can have a separate conduct to embody the data. All these above stated problems are solved in an easy and an elegant approach by the FTP.

The FTP protocol is different from the normal server and the user applications as this makes two handshakes between the servers. One handshake is the connection establishment which is used for data transmission.
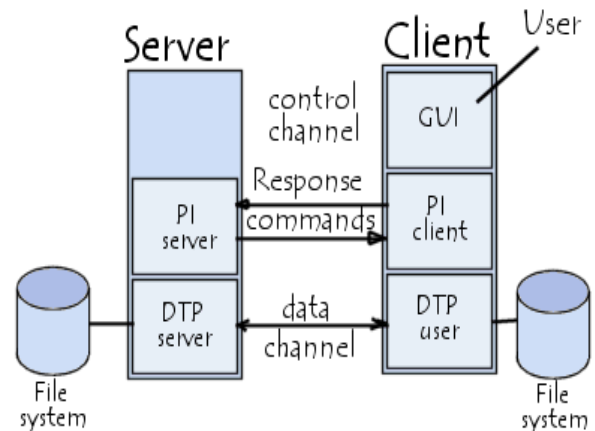

Figure.8 FTP Protocol

FTP FUNCTIONS:

FTTP functions as both server and the client in the internet or the network.

A.   Functions as Server:

The FTP server provides you the services that can be used by us to install files on the server, manage all of the files and download the files easily from the server when we require them.

B.   Functions as Client:

The FTP client helps us to connect with the server of the FTP on the port, so we can upload, download, delete, change settings related to the files and also rename the files easily.

FTP ADVANTAGES:

- File transfer protocol is the fastest protocol for downloading of large files.
- It's a very efficient protocol as it doesn't require us to end many tasks in-order to transfer the   file or files.
- FTP servers require   a username and password.
- FTP enables us to transfer files forth and back.

FTP DISADVANTAGES:

- File contents and the passwords are sending in the form of clear text, which allow some unwanted eavesdropping.
- Its quiet difficult to filter the active mode of the FTP traffic on the client using the firewall settings.
- In FTP it is possible for us to send the data on a random port of the any other computer.

E. ETHERNET:

This protocol is a part of structured based computer networking technologies and is used in local area networks. Ethernet protocol is most extensively used protocol. Ethernet requires the twisted pair wires or coaxial cables for the establishment of connection. This protocol is a cheap fast speed local area network used now days. Ethernet has replaced many other LANs due to its speed.
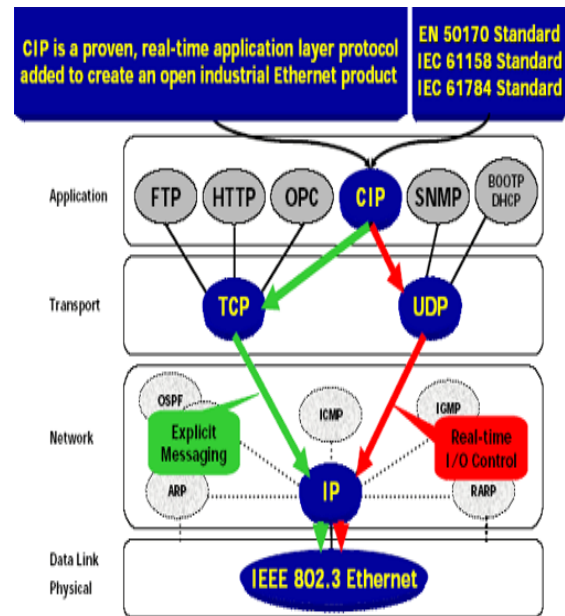

Figure.9 Ethernet Protocol Working

Figure Courtesy
http://www.hms.se/images/eip_overview.png

Ethernet is standard IEEE 802.3 protocol, which is made up of combination of the twisted paired wires and are used to connect or make them part of the network. Ethernet uses the bus or the star topology for the data transmission in the network. This protocol explains the lower two layers of the OSI model. There are two media access controls present in the Ethernet the half duplex and the full duplex.

FUNCTIONS OF ETHERNET:

- Ethernet is a networking protocol used for local networks
- Ethernet tells about the wiring necessary to be used for the frame formats and for the protocols.
- It also makes the computers to communicate by connecting them all together.

ADVANTAGES OF ETHERNET:

- Multiple computers can be connected together using the Ethernet protocol.
- It is quite faster to transfer large data packets and large files on the network without any delay.
- It's very easy to install the Ethernet.

DISADVANTAGES OF ETHERNET:

- In Ethernet for connecting to the internet you need hub.
- Very difficult for us to install the Ethernet connection on two or more computers that are within the network.
- Difficult to establish internet for two or more computers using the Ethernet.

F. POINT TO POINT PROTOCOL (PPP)

Point-to-Point Protocol is mostly used for establishing a direct linking among two nodes (servers, computers). PPP is also able to link computers through telephones, phone lines, cables, fiber optics etc. Many of the Internet Service Provider (ISP) uses the PPP for the customer's dial-up connection to access the internet. Point –To-point was planned to be designed in such manner that it can enable the communication of many different protocols over one point-to-point connection by using the technique or process of encapsulation. Encapsulation is a technique through which packets are stored from various types of protocols present within the Point-to-Point frames. PPP is able of working transversely with every type of interfaces. It does not impose any type of limit regarding transmission rate.
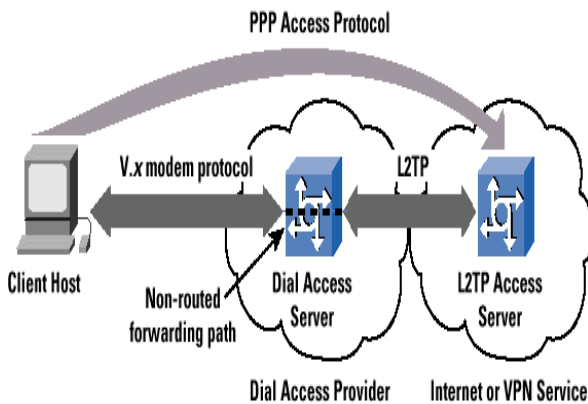

Figure.10 Point-To-Point Protocol (PPP) Working

FUNCTIONS OF POINT-TO-POINT:

- It is designed in-order to transport multiple protocol data packets between two or more computers linked through easy connections.
- The links of PPP provide full duplex bi-directional operations.

ADVANTAGES OF POINT-TO-POINT PROTOCOL:

- One of the main advantages of PPP is that it is extensible protocol suite.
- It is can do operations in any type of interfaces.
- There is no restriction related to transmission rate in the point –to-point protocol.

DISADVANTAGES OF POINT-TO-POINT PROTOCOL:

- This protocol is not very much reliable for data transmission at large scale.

G. INTERNET PROTOCOL (IP):

IP is an important network protocol which is being used by the internet providers. The protocol was launched in 1970s. it is very important protocol of the internet and the networking and is very much used. Internet Protocol is basically a set of technical rules which tell that how the computers interact with each other over the network. IP functions as the networking layer of the internet.

The data in the IP network is in the form of packets. . Every IP data packet contains a header which contains source and destination addresses and also other information about the packet of the data and it also contains the message data itself and also each packet of the data is processed separately. The TCP/IP protocol is basically used as communication medium for the transportation of the IP data packets over the network. The IP protocol is most widely used.

TYPES OF IP PROTOCOL:

There are two main types of IP protocol including IPV4 and IPV6.

Table.III IPV4 and IPV6

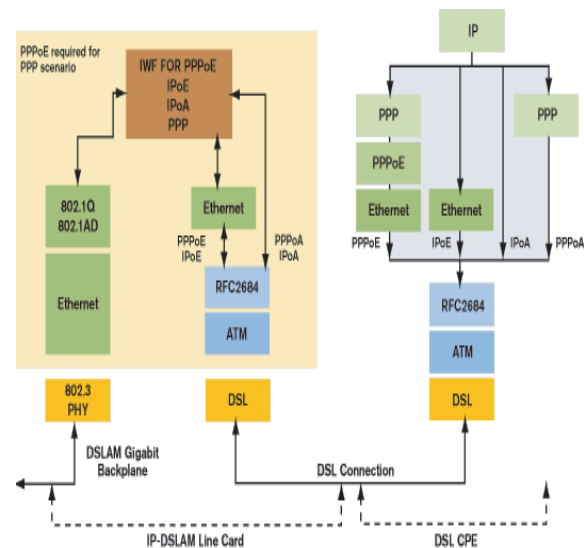|	IPV4	IPV6
Introduced	1981	1999
Address format	decimal format 192.149.252.76	hexa- decimal format 3FFE:F200:0234:AB00:0123:4567:8901:ABCD
Address size	32 bit address space	128 bit address space
Notation	192.149.0.0/24	3FFE:F200:0234::/48
Addresses number	232	2128

Figure.11 IP Protocol

Courtesy:
http://www.element-14.com/community/docs/DOC-2831/l/block-diagrams-freescale-internet-protocol-ip-dslam

Functions of the IP:

Addressing:

IP data packet header include the addresses of the sending and the receiving computers. The routing devices use this data for guiding each of the data packet across the communication networks and also connect the sender and receiver**.**

FRAGMENTATION:

The IP data packets are fragmented, into smaller packets. This does not allow a larger data packet to move over the entire network which is capable to handle only smaller data packets. IP fragments the data packets and reassembles all of the data packets.

TIME OUT:

In the IP protocol each data packet is allocated a time slot to travel or move across the network. When this time slot gets expired than that data packet is discarded.

ADVANTAGES OF IP:

1. The IP provides information related to the clients /servers that can access the Internet.
2. IP checks the addressing of the data packets or the message so that it is sent to the right destination.
3. This protocol is capable of handling the errors.

DISADVANATGES OF IP:

1. The data packets are not sent in proper order.
2. The packet is divided into number of different small packets.
3. Data packet is lost if time gets expired.

H. WI-MAX PROTOCOL:

In mid 1990s different communication companies decided to introduce an approach to use wire-less networks for the communication purpose so that it is possible to send and receive the data at a larger distance without the use of cables, wires etc. so in this way many different wireless technologies were introduced and in the last wi-max or wi-fi was introduced in 2001. Later on much advancement was made in the Wi-max and its speed as well as quality was enhanced. Wi-max is integrated as the 3G technology used now-days.

Wi-max is an IP based protocol which performs a similar to the IEEE 802.11. Wimax is standard protocol used now days. The data transmission using the Wi-MAX is very much easy because it does not require any cables or wires for the transmission of the data rather it uses waves for the transmission of data. For accessing of internet using the wi-fi technology we do not need any cable or wire. Different wi-fi technologies are used now a day for accessing the internet like wi-fi cards which are capable to catch the signals from the antenna.
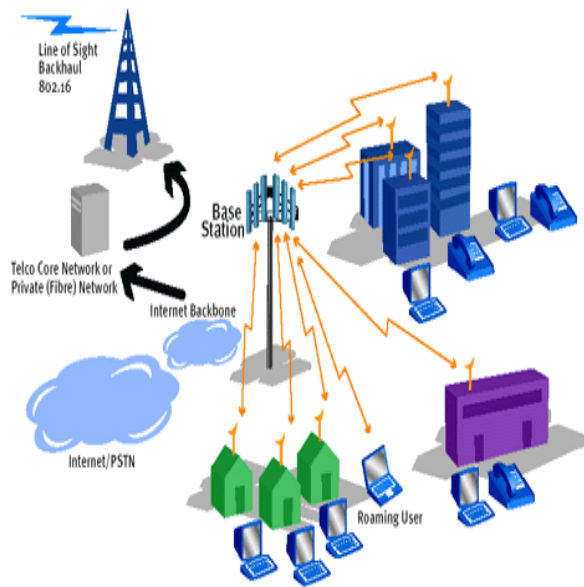

Figure.12 WI-MAX Protocol

Courtesy:
http://btechzone.com/wp-content/uploads/2010/08/060809_WiMax.gif

WORKING OF WI-MAX:

Wi-MAX working requires following two things [7]:

Wi-MAX Base Station:

The base station consists of electronics which are used indoor also it requires a Wi-MAX tower for the connection. Base station is capable of covering up to 10 km radius. If wireless node is present within that coverage area it can access the internet [8].

Wi-MAX receiver:

Both the antenna and the receiver can be a box or wimax card that is used to access the internet. Wi-MAX has a base station which is similar to that of the Wireless Access Point present in the Wi-Fi network, but the range of the wimax is more.
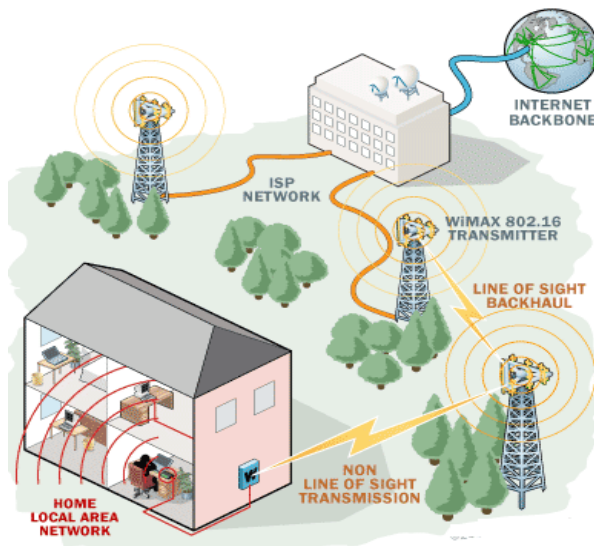
Figure.13 WI-MAX Working

Advantages of Wi-max:

- An important advantage of wi-max is that it is completely wi-free i.e. it does not require any wiring or cables.
- Wi-max supports roaming i.e. it can be accessed from any where.
- It has contains a global standard i.e. the user can access the internet from any where.

Disadvantages of Wi-max:

- One of the main disadvantages is the problem of security in the wi-max.
- Wi-max is not helpful when any interface comes due to waves such as microwaves or the phones which have the same frequency that is used by 802.11g and 802.11b i.e. 2.4GHZ

III. APPLICATION AREAS

There are wide ranges of applications of the networking. Networking is very much used in every field of life now a day. The use of the networking is increasing day-to-day at a very high speed. Some applications are:

- Groupware is new networking application developed which allows the groups of different users to share their files, databases schedules.
- Due to networking the scheduling of the programs allow the users to easily access the network and schedule there meetings, appointments and other important tasks.
- Teleconferencing application of the networking allows the users to attend their meetings or conferences using the telephone lines [9].
- The Internet service providers can easily assign IP's to the users with the help of the networking.
- The remote accessing of the networking allows the persons to easily manage their office works form any corner of the world.

- The application of networking value added networks which can be public or private give a leased connection to all of their clients [9], [10].
- Due to networking the Automated ATM machines allow customers to access their accounts and to do transactions from any corner of the world

IV. CONCLUSION

This research paper is basically about the network protocols. It enables the reader to know about all of the important networking protocols, how these protocols function and all other information which is very much necessary for the protocols. The paper is providing an analysis of all the core protocols of the networking. The different design and application oriented characteristics of different protocoles have been disscussed in detail. The working flow of each of these protocoles have also been explained with the help of internal working concepts.

V. REFERENCES

[1] Kazi Chandrima Rahman, "A Survey On Sensor Network" , ISSN 2218-5224, Vol. 01,ISSUE 01, published in 2010

[2] Yonghui chen, chunfeng zhang and zhiqin liu, "Energy Efficient Routing Protocol Based on Energy of node and Stability of Topology,"in 3rd International conference on Information and computing 2010.

[3] Johan Garcia, Stefan Alfredsson , Anna Brunstrom "The impact of loss generation on emulation-based protocol evaluation" Proceedings of .the 24th IASTED international conference on Parallel and distributed computing and networks Feb 14, 2006 Innsbruck Australia Page no.231-237

[4] Steven Bassi , Miguel A. Labrador, Setting up a Web100-Dummynet "Test bed for research in transport layer protocols", Proceedings of the 43rd annual southeast regional conference, March 18-20, 2005, Kennesaw, Georgia

[5] W. Richard Stevens "TCP/IP Illustrated, The Protocols",. Published by Addison-Wesley. Volume 1 ISBN0-20-163346-9.

[6] Gaurav Gupta, Mohamed Younis "Fault-Tolerant Clustering of WirelessSensor Networks" 2003 IEEE Ameer Ahmed Abbasi and Mohamed Younis: A survey on clustering algorithms for wirelesssensor networks, Computer Communications Volume 30, Issues 14-15, 15 October 2007,Pages 2826-2841.

[7] M. Junaid , Dr Muid Mufti and M.Umar Ilyas, "Vulnerabilities ofIEEE 802.11i Wireless LAN CCMP Protocol", In the Proceedings Of World Academy Of Science, Engineering And Technology Volume11,February2006

[8] K.C. Leung and V.O.K Li, "Generalized Load Sharing for Packet Switching Network I: Theory and Packet Based Algorithm", IEEE transaction Parallel and distributed system ISSN

[9] Protocol in Mobile Ad Hoc Networks", International Journal of Recent Trends in Engineering, Vol 2, No. 2, November 2009

[10] Jillian Cannons, Randall Dougherty, Chris Freiling, and KennethZeger," Network Routing Capacity", IEEE transactions on information theory, vol. 52, no. 3, march 2006